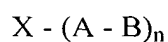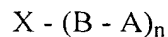What is claimed is:

1.   A water-soluble block copolymer having a mass average molecular weight of 2500 to 800000 and comprising, within a molecule, a poly(ethylene imine) block unit and a poly(N-propionylethylene imine) block unit.

2.   A water-soluble block copolymer according to claim 1 represented by one of general formula (1a):
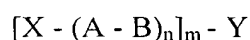
X - (A - B)$_n$

and general formula (1b):

X - (B - A)$_n$

(in the formulae, X is a residue of a monovalent or greater polymerization initiator; A is the poly(ethylene imine) block unit; B is the poly(N-propionylethylene imine) block unit; and n is an integer being at least 1 and being within a range of valences of X).

3.   A water-soluble block copolymer according to claim 1 represented by one of general formula (2a):

[X - (A - B)$_n$]$_m$ - Y

and general Formula (2b):
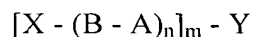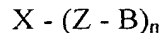
[X - (B - A)$_n$]$_m$ - Y

(in the formulae, X is a residue of a monovalent or greater polymerization initiator; A is the poly(ethylene imine) block unit; B is the poly(N-propionylethylene imine) block unit; Y is a residue of a monovalent or greater terminal compound; n is an integer being at least 1 and being within a range of valences of X; and m is an integer being at least 1 and being within a range of valences of X).
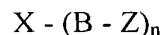
4.   A water-soluble block copolymer according to claim 1, wherein a molar ratio of the poly(N-propionylethylene imine) block unit is 0.1 to 0.95 with respect to the poly(ethylene imine) block unit.

5.   A water-soluble block copolymer according to one of claims 2 and 3, wherein X is the residue of the polymerization initiator having a valence of from 1 to 12.

6.   A water-soluble block copolymer according to claim 3, wherein Y is the residue of the terminal compound having a valence of from 1 to 12.

7.   A water-soluble block copolymer according to one of claims 2 and 3, wherein X is the residue of the polymerization initiator having a skeleton of one of a benzene skeleton, a porphyrin skeleton, a phthalocyanine skeleton, and a pyrene skeleton.

8.   A water-soluble block copolymer according to claim 3, wherein Y is the residue of the terminal compound having a skeleton of one of a benzene skeleton, a porphyrin skeleton, a phthalocyanine skeleton, and a pyrene skeleton.

9.   A production method for a water-soluble block copolymer comprising:

forming an emulsion by dispersing a water-soluble block copolymer having, in a molecule, a poly(N-formylethylene imine) block unit or a poly(N-acetylethylene imine) block unit, and a poly(N-propionylethylene imine) block unit in a solvent mixture of water and an organic solvent which is not compatible with water and in which poly(N-propionylethylene imine) is soluble; and

preferentially hydrolyzing the poly(N-formylethylene imine) block unit or the poly(N-acetylethylene imine) block unit of the water-soluble block copolymer in the presence of an acid or an alkali.

10.   A production method for a water-soluble block copolymer according to claim 9, wherein the water-soluble block copolymer having, in the molecule, the poly(N-formylethylene imine) block unit or the poly(N-acetylethylene imine) block unit, and the poly(N-propionylethylene imine) block unit is represented by one of:
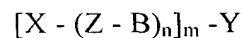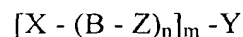
general formula (3a):

$$X - (Z - B)_n$$

general formula (3b):

$$X - (B - Z)_n$$

general formula (3c):

$$[X - (Z - B)_n]_m - Y$$

and general formula (3d):

$$[X - (B - Z)_n]_m - Y$$

(in the formulae, Z is the poly(N-formylethylene imine) block unit or the poly(N-acetylethylene imine) block unit; X is a residue of a monovalent or greater polymerization initiator; B is the poly(N-propionylethylene imine) block unit; n is an integer being at least 1 and being within a range of valences of X; and m is an integer of at least 1 being within a range of valences of X).

11. A production method for a water-soluble block copolymer according to claim 9, wherein a molar ratio of the poly(N-propionylethylene imine) block is 0.1 to 0.9 with respect to the poly(N-formylethylene imine) block unit or the poly(N-acetylethylene imine) block unit.

12. A production method for a water-soluble block copolymer according to claim 9, wherein a molar number of the acid or alkali is from 1 to 50 times the molar number of the monomer units making up the poly(N-formylethylene imine) block unit or the poly(N-acetylethylene imine) block unit.